REMARKS

The application has been reviewed in light of the Office Action dated February 8, 2007. Claims 1-18 were pending. By this Amendment, claims 13, 17 and 18 have been canceled, without prejudice or disclaimer, new claim 19 has been added, and claims 1, 3, 4, 8-12, 15 and 16 have been amended to clarify the claimed subject matter. Accordingly, claims 1-12, 14-16 and 19 are now pending, with claims 1 and 11 being in independent form.

Claims 3, 10, 11, 15 and 16 were objected to as purportedly having informalities. Claims 9 and 10 were rejected under 35 U.S.C. §112, second paragraph, as allegedly indefinite.

By this Amendment, claims 1, 3, 4, 8-12, 15 and 16 have been amended to clarify the claimed subject matter.

Withdrawal of the objection to the claims and the rejection under 35 U.S.C. §112, second paragraph, is respectfully requested.

Claims 1-7, 11-15, 17 and 18 were rejected under 35 U.S.C. § 102(b) as purportedly anticipated by U.S. Patent No. 6,559,643 to Miyoshi. Claim 8 was rejected under 35 U.S.C. § 103(a) as purportedly unpatentable over Miyoshi in view of U.S. Patent No. 6,392,411 to Goto. Claim 16 was rejected under 35 U.S.C. § 103(a) as purportedly unpatentable over Miyoshi in view of U.S. Patent No. 6,867,590 to Carlini.

Applicant has carefully considered the Examiner's comments and the cited art, and respectfully submits that independent claims 1 and 11 are patentable over the cited art, for at least the following reasons.

This application relates to a technique devised by applicant for correcting, in real time, an undesirable residual magnetic field which is being generated due to the application of a gradient

magnetic field in magnetic resonance (MR) imaging, taking into consideration the application history of the gradient magnetic field. For example, in the method of claim 1 of the present application, correction of the residual magnetic field is performed along with the application of each pulse of the gradient magnetic field which is used for magnetic resonance imaging, and the residual magnetic field response function for calculating the residual magnetic field is updated along with the application of each pulse of the gradient magnetic field. Each of independent claims 1 and 11 addresses these features, as well as additional features. Additional details can be found in paragraphs [0190] through [0194] and Fig. 19 of this application

Miyoshi, as understood by Applicant, proposes an approach for dealing with residual magnetization caused by a previous MR imaging pulse sequence on an MR image, wherein a demagnetizing gradient pulse sequence is applied prior to an MR imaging pulse sequence to cancel the residual magnetization caused by the previous MR imaging pulse sequence and reduce the residual magnetization.

Miyoshi, column 6, lines 18-67, which was cited in the Office Action, states as follows:

> In the residual magnetization measuring pulse sequence of FIG. 3, first through fourth gradient pulses RS1-RS4 are consecutively applied to the phase axis. The first through fourth gradient pulses RS1-RS4 have trapezoidal waveforms, alternately inverting polarity and pulse heights halved in order. The pulse height of the first gradient pulse RS1 is such that it saturates the residual magnetization. Moreover, the pulse widths of the first through fourth gradient pulses RS1-RS4 are substantially the same.
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> Next, an excitation pulse R is transmitted and a slice gradient ss1 is applied to the slice axis. Next, a first inversion pulse P1 is transmitted and a slice gradient ss2 is applied to the slice axis, and further first crusher gradients cr1 are applied to the read axis before and after the first inversion pulse P1. Next, a dephaser gradient dp1 is applied to the phase axis, and an NMR signal of the first echo echo1 is then received while applying a read gradient RD1 to the phase axis, whereafter a rephaser gradient rp1 equal to the dephaser gradient dp1 is applied to the phase axis.
>
> Next, a second inversion pulse P2 is transmitted and a slice gradient ss3 is applied to the slice axis, and further second crusher gradients cr2 are applied to the read axis

> before and after the second inversion pulse P2. Next, a dephaser gradient dp2 is applied to the phase axis, and an NMR signal of the second echo echo2 is then received while applying a read gradient RD2 to the phase axis, whereafter a rephaser gradient rp2 equal to the dephaser gradient dp2 is applied to the phase axis.
>
> Although the crusher gradients cr1 and cr2 are applied in order to eliminate a stimulated echo and FID (free induction decay) signal, which disturb the measurement of phase error, they may be omitted.
>
> ***Returning to FIG. 2, in Step E2, an offset of an echo peak is determined from the data of the first and second echoes echo1 and echo2, and a residual magnetization amount Δ is determined from the offset of an echo peak.***
>
> ***The residual magnetization amount Δ measured by the above process represents the magnitude of residual magnetization caused by the first through fourth gradient pulses RS1-RS4.***
>
> Then, an appropriate allowed value is defined, and if the residual magnetization amount Δ is greater than the allowed value, the residual magnetization amount Δ is repeatedly measured after modifying the pulse heighus of the second through fourth gradient pulses RS2-RS4. When the residual magnetization amount Δ has become less than the allowed value, the first through fourth gradient pulses RS1-RS4 at that time are determined as a demagnetizing gradient pulse sequence.

Thus, Miyoshi proposes an approach for determining a demagnetizing gradient pulse sequence (RS1-RS4), wherein the first through fourth gradient pulses RS1-RS4 are applied between a previous MR imaging pulse sequence and a next MR imaging pulse sequence, and ***<u>not</u>*** along with each MR imaging pulse sequence or with the application of the gradient magnetic field for MR imaging, as provided by the subject matter of claim 1 of the present application.

Miyoshi simply does not teach or suggest a magnetic resonance imaging method comprising (2) calculating a residual magnetic field being generated in the magnetic device by an applied gradient magnetic field on the basis of a residual magnetic field response function that represents the relation between the strength of the applied gradient magnetic field and the strength of the residual magnetic field being generated by the applied gradient magnetic field, (3) correcting the residual magnetic field calculated in the step (2) along with the application of each pulse of the gradient magnetic field, and (4) a step for updating the residual magnetic field

response function in accordance with the strength of each pulse of the applied gradient magnetic field along with the application of the gradient magnetic field pulses, wherein the calculation of the residual magnetic field in (2) is executed by using the residual magnetic field response function updated in (4), as provided by the subject matter of claim 1 of the present application.

The method of claim 1 of the present application is useful for almost all types of sequences, and there is no need to determine demagnetizing gradient pulse sequence (RS1-RS4) as proposed by Miyoshi.

Goto, as understood by Applicant, proposes an approach directed to the problem of phase shifts in subsequent echoes due to the influence of eddy currents and residual magnetization caused by each preceding phase encoding pulse or the like in the pulse sequence in MR imaging. Goto was cited in the Office Action as purportedly showing charts that represent the relationship between applied gradient magnetic field and residual magnetic field.

However, Goto, like Miyoshi, does not teach or suggest a magnetic resonance imaging method comprising (2) calculating a residual magnetic field being generated in the magnetic device by an applied gradient magnetic field on the basis of a residual magnetic field response function that represents the relation between the strength of the applied gradient magnetic field and the strength of the residual magnetic field being generated by the applied gradient magnetic field, (3) correcting the residual magnetic field calculated in the step (2) along with the application of each pulse of the gradient magnetic field, and (4) a step for updating the residual magnetic field response function in accordance with the strength of each pulse of the applied gradient magnetic field along with the application of the gradient magnetic field pulses, wherein the calculation of the residual magnetic field in (2) is executed by using the residual magnetic

field response function updated in (4), as provided by the subject matter of claim 1 of the present application.

Carlini, as understood by Applicant, proposes an approach for compensating for eddy currents induced by the switching on and off magnetic fields in gradient coils in NMR imaging apparatuses. Carlini was cited in the Office Action as purportedly proposing use of correction coils for compensating for the gradient-induced eddy currents

Applicant does not find teaching or suggestion in the cited art, however, of a magnetic resonance imaging method comprising (2) calculating a residual magnetic field being generated in the magnetic device by an applied gradient magnetic field on the basis of a residual magnetic field response function that represents the relation between the strength of the applied gradient magnetic field and the strength of the residual magnetic field being generated by the applied gradient magnetic field, (3) correcting the residual magnetic field calculated in the step (2) along with the application of each pulse of the gradient magnetic field, and (4) a step for updating the residual magnetic field response function in accordance with the strength of each pulse of the applied gradient magnetic field along with the application of the gradient magnetic field pulses, wherein the calculation of the residual magnetic field in (2) is executed by using the residual magnetic field response function updated in (4), as provided by the subject matter of claim 1 of the present application.

Independent claim 11 is patentably distinct from the cited art for at least similar reasons.

Accordingly, for at least the above-stated reasons, Applicant respectfully submits that independent claims 1 and 11, and the claims depending therefrom, are patentable over the cited art.

In view of the remarks hereinabove, Applicant submits that the application is now in condition for allowance, and earnestly solicits the allowance of the application.

If a petition for an extension of time is required to make this response timely, this paper should be considered to be such a petition. The Patent Office is hereby authorized to charge any fees that are required in connection with this amendment and to credit any overpayment to our Deposit Account No. 03-3125.

If a telephone interview could advance the prosecution of this application, the Examiner is respectfully requested to call the undersigned attorney.

Respectfully submitted,

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